DESCRIPTION

HIGH SPEED DUBBING APPARATUS

TECHNICAL FIELD

[0001] The present invention relates to techniques for converting bit streams conforming to the DVD video recording standard (DVD Specifications for Rewritable/Re-recording Discs, Part 3) into a bit stream conforming to the DVD video standard (DVD Specifications for Read-Only Disc, Part 3).

BACKGROUND ART

[0002] Recording on DVDs (Digital Versatile Discs) is performed according the DVD video recording (DVD-VR) standard or the DVD-video standard. The DVD-VR standard is used for real-time recording of contents. On the other hand, contents recorded according to the DVD-video standard can be played back by DVD players which are exclusively used for playback.

[0003] In digital recording equipment such as DVD recorders, recording is generally performed according to the DVD-VR standard because editing is easy. However, to perform playback by other equipment such as a DVD player, it is necessary to convert the format of a content recorded according to the DVD-VR standard into another format conforming to the DVD-video standard.

[0004] To convert the format of a recorded content from the DVD-VR standard into the DVD-video standard, a method in which a digital signal is decoded, coded again and then recorded can be used. In this method, however, coding is performed again after decoding. Accordingly, this method has not only a problem in which the time necessary for the conversion is equal to the actual length of the content but also a problem in which the image quality of the content deteriorates.

[0005] In view of this, a technique of converting a digital-recorded content into

another format while leaving the content digital without decoding is proposed. For example, an apparatus and a method for converting a bit stream in an RTR (Real Time Recording) format into a bit stream in a DVD-video standard format are disclosed in Patent Document 1. Hereinafter, a conversion in which a bit stream conforming to the DVD-VR standard as data in the RTR format is directly converted into a bit stream conforming to the DVD-video standard while leaving the bit stream digital without decoding will be referred to as a "digital conversion".

Patent Document 1: Japanese Unexamined Patent Publication No. 2003-242721

DISCLOSURE OF INVENTION

PROBLEMS THAT THE INVENTION IS TO SOLVE

[0006] Dubbing for converting a bit stream conforming to the DVD-VR standard format into a bit stream conforming to the DVD-video standard format needs processes of stream readout, navigation pack generation, stream rewriting and stream writing, so that the time which is the sum of the time necessary for all these processes is needed.

[0007] However, the time necessary for stream readout and stream writing depends on the performance of a storage device. Specifically, even if the speed of the other processes is increased, the total speed of dubbing is limited by stream readout and stream writing, so that a problem in which the dubbing speed cannot be increased to a certain level arises.

[0008] An object of the present invention is to reduce the time necessary for dubbing of a bit stream from a storage device to another storage device.

MEANS OF SOLVING THE PROBLEM

[0009] In one aspect of the present invention, a high speed dubbing apparatus includes: a read section for reading a bit stream conforming to a DVD-VR standard from a first storage device, and outputting the bit stream; a first buffer for storing an output from

the read section and outputting a bit stream; a navigation pack generator for replacing a real time data information pack in the bit stream output from the first buffer with a navigation pack, and outputting a resultant bit stream; a second buffer for storing an output from the navigation pack generator and outputting a bit stream; and a write section for converting the bit stream output from the second buffer into a bit stream conforming to a DVD-video standard, and writing the resultant bit stream in a second storage device, wherein at least two of the read section, the navigation pack generator and the write section operate in parallel.

[0010] With this configuration, the first and second buffers allow reading from the first storage device or writing in the second storage device to be performed in parallel with another processing. Accordingly, reading of a bit stream conforming to the DVD-VR standard and conversion of this bit stream into a bit stream conforming to the DVD-video standard to write the resultant bit stream are performed at high speed.

[0011] In the high speed dubbing apparatus, it is preferable that the read section includes a stream analyzer for analyzing the bit stream read out from the first storage device and outputting obtained stream analysis information, the navigation pack generator performs the replacement using the stream analysis information, and the write section includes a stream rewriting unit for performing the conversion using the stream analysis information.

[0012] In the high speed dubbing apparatus, the first buffer preferably has a capacity equal to or less than the capacity of a cache memory included in the first storage device.

[0013] In the high speed dubbing apparatus, the second buffer preferably has a capacity equal to or less than the capacity of a cache memory included in the second storage device.

[0014] It is preferable that the high speed dubbing apparatus further includes a buffer checking unit for measuring the capacity of a cache memory included in the first storage device and outputting a measurement result by performing reading from the

first storage device, and the capacity of the first buffer is changed according to the measurement result.

[0015] It is preferable that the high speed dubbing apparatus further includes a buffer checking unit for measuring, by performing writing in the second storage device, the capacity of a cache memory included in the second storage device and outputting a measurement result, and the capacity of the second buffer is changed according to the measurement result.

[0016] It is preferable that the high speed dubbing apparatus further includes a buffer checking unit for measuring the capacity of a cache memory included in the first storage device by performing reading from the first storage device, for measuring the capacity of a cache memory included in the second storage device by performing writing in the second storage device, and for outputting a smaller one of obtained measurement results, and the capacities of the first and second buffers are changed to a capacity indicated by the measurement result.

[0017] In the high speed dubbing apparatus, it is preferable that the read section reads bit streams in parallel from a plurality of said first storage devices in each of which portions of data in the DVD-VR standard format each corresponding to a given number of bits are stored, and the read section outputs the readout bit streams as one bit stream.

[0018] The given number is preferably 16.

[0019] The given number is preferably 8.

[0020] It is preferable that the high speed dubbing apparatus includes a plurality of said first buffers, the read section reads a bit stream from a plurality of said first storage devices in each of which a portion of data in the DVD-VR standard format corresponding to data of a given size is stored and provides an output to a buffer associated with one of the first storage devices from which the readout bit stream has been output, and after reading from one of the first storage devices has started, reading from another one of the first storage devices starts.

[0021] The given size is preferably an integral multiple of the size of a VOBU

(Video Object Unit).

[0022] It is preferable that the high speed dubbing apparatus further includes a write unit for writing, in the first storage device, a bit stream obtained by conversion in the write section and conforming to the DVD-video standard, the read section reads the bit stream conforming to the DVD-video standard and written in the first storage device in the case of performing, after termination of dubbing of a content, dubbing of the content again, and the write section writes the bit stream conforming to the DVD-video standard and read out by the read section in the second storage device.

[0023] In the case of dubbing of a portion of the bit stream conforming to the DVD-video standard and read out by the read section, the navigation pack generator preferably modifies a portion of information included in a navigation pack of the bit stream.

[0024] In the case of dubbing of a portion of the bit stream conforming to the DVD-video standard and read out by the read section, the write section preferably removes a PES_extension_field in the bit stream or modifies time information.

[0025] It is preferable that the high speed dubbing apparatus further includes a filter for controlling an output of the bit stream obtained by conversion in the write section and conforming to the DVD-video standard to the second storage device, the read section monitors copyright information on the bit stream read out from the first storage device and conforming to the DVD-VR standard and outputs a monitoring result, and the filter does not output the bit stream conforming to the DVD-video standard to the second storage device when the monitoring result of the copyright information output from the read section indicates prohibition of copying.

[0026] The read section preferably monitors CGMS (Copy Generation Management System) information as the copyright information.

[0027] It is preferable that when copyright information on a first portion of the bit stream conforming to the DVD-VR standard indicates prohibition of copying and copyright information on a second portion following the first portion indicates allowance of copying, the read section holds time information on the first portion and

uses, as time information on the second portion, a result obtained by subtracting the time information on the first portion from time information on the second portion.

[0028] In another aspect of the present invention, a high speed dubbing apparatus includes: a read section for reading a bit stream conforming to a DVD-VR standard and a navigation pack added to the bit stream from a first storage device, removing one of a real time data information pack and the navigation pack in the bit stream, and producing an output; a buffer for storing the output from the read section and outputting a bit stream; and a write section for converting the bit stream output from the buffer into a bit stream conforming to a DVD-video standard, and writing the resultant bit stream in a second storage device, wherein the read section and the write section operate in parallel.

[0029] With this configuration, generation of a navigation pack is unnecessary, so that it is sufficient to provide a buffer only between the read section and the write section. This enables reduction of a circuit scale.

[0030] The buffer preferably has a capacity equal to or less than the capacity of a cache memory included in the first storage device and equal to or less than the capacity of a cache memory included in the second storage device.

[0031] It is preferable that the high speed dubbing apparatus further includes a buffer checking unit for measuring the capacity of a cache memory included in the first storage device by performing reading from the first storage device, measuring the capacity of a cache memory included in the second storage device by performing writing in the second storage device, and outputting a smaller one of obtained measurement results, the capacity of the buffer is changed to a capacity indicated by the measurement result.

EFFECT OF THE INVENTION

[0032] According to the present invention, reading of a bit stream conforming to the DVD-VR standard from a storage device and conversion of the bit stream into a bit stream conforming to the DVD-video standard to write the resultant bit stream in a

storage device are performed at high speed. Accordingly, a dubbing process in which pictures recorded on a recording medium in a storage device according to the DVD-VR standard format, for example, are recorded on, for example, another recording medium in another storage device according to the DVD-video standard format is performed at high speed.

BRIEF DESCRIPTION OF DRAWINGS

[0033] [FIG. 1] FIG. **1** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a first embodiment of the present invention.

[FIG. 2] FIG. **2** is an explanatory diagram illustrating a directory structure of a disk on which information is recorded according to the DVD-VR standard.

[FIG. 3] FIG. **3** is an explanatory diagram illustrating a directory structure of a disk on which information is recorded according to the DVD-video standard.

[FIG. 4] FIG. **4** is an explanatory diagram illustrating structures of VOBs conforming to the DVD-VR standard and the DVD-video standard, respectively.

[FIG. 5] FIG. **5** is an explanatory diagram illustrating a structure of a real time data information pack (RDI_PCK).

[FIG. 6] FIG. **6** is an explanatory diagram illustrating a structure of a navigation pack (NV_PCK).

[FIG. 7] FIG. **7** is an explanatory diagram illustrating structures of video packs (V_PCKs).

[FIG. 8] FIG. **8** is an explanatory diagram illustrating structures of audio packs (A_PCKs).

[FIG. 9] FIG. **9** is a block diagram illustrating an example of a configuration of a first storage device from which a bit stream is read out.

[FIG. 10] FIG. **10** is a block diagram illustrating an example of a configuration of a second storage device in which a bit stream is written.

[FIG. 11] FIG. 11 is a block diagram illustrating a configuration of a read unit illustrated in FIG. 1.

[FIG. 12] FIG. 12 is an explanatory diagram illustrating a storage state of a content in the DVD-VR standard format in a storage device illustrated in FIG. 1.

[FIG. 13] FIG. 13 is an explanatory diagram illustrating removal of a PES_extension_field using stuffing bytes.

[FIG. 14] FIG. 14 is an explanatory diagram illustrating removal of a PES_extension_field using a padding packet.

[FIG. 15] FIG. 15 is a timing chart showing an example of processing in the high speed dubbing apparatus illustrated in FIG. 1.

[FIG. 16] FIG. 16 is a timing chart showing an example of data transfer between a read unit and a storage device illustrated in FIG. 1.

[FIG. 17] FIGS. 17(a) through (c) are timing charts showing examples of the case of performing two processes in parallel in the high speed dubbing apparatus illustrated in FIG. 1.

[FIG. 18] FIG. 18 is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a second embodiment of the present invention.

[FIG. 19] FIG. 19 is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a third embodiment of the present invention.

[FIG. 20] FIG. 20 is an explanatory diagram illustrating an example of a format of a bit stream output from a storage device illustrated in FIG. 19.

[FIG. 21] FIG. 21 is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a fourth embodiment of the present invention.

[FIG. 22] FIG. 22 is a block diagram illustrating a configuration of a read unit

illustrated in FIG. **21**.

[FIG. **23**] FIG. **23** is an explanatory diagram illustrating storage states of a content in the DVD-VR standard format in two storage devices illustrated in FIG. **22**.

[FIG. **24**] FIG. **24** is a timing chart showing examples of processing in the high speed dubbing apparatus illustrated in FIG. **21**.

[FIG. **25**] FIG. **25** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a fifth embodiment of the present invention.

[FIG. **26**] FIG. **26** is an explanatory diagram illustrating storage states of a content in the DVD-VR standard format in two storage devices illustrated in FIG. **25**.

[FIG. **27**] FIG. **27** is a block diagram illustrating a configuration of a read unit illustrated in FIG. **25**.

[FIG. **28**] FIG. **28** is a timing chart showing examples of processing in the high speed dubbing apparatus illustrated in FIG. **25**.

[FIG. **29**] FIG. **29** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a sixth embodiment of the present invention.

[FIG. **30**] FIG. **30** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a seventh embodiment of the present invention.

[FIG. **31**] FIG. **31** is an explanatory diagram illustrating remodification of SCRs.

BRIEF EXPLANATION OF REFERENCE NUMERALS

[0034] 10, 310, 410, 412, 510, 512 first storage device

16, 76 cache memory

20, 320, 420, 520 read section

26, 326, 526, 527 stream analyzer

30, 230, 530, 532 first buffer

40 navigation pack generator

50, 250 second buffer

60, 660, 760 write section

70 second storage device

100, 200, 300, 400, 500, 600, 700 high speed dubbing apparatus

324, 766 filter

BEST MODE FOR CARRYING OUT THE INVENTION

[0035] Hereinafter, embodiments of the present invention will be described with reference to the drawings.

[0036] (EMBODIMENT 1)

FIG. **1** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a first embodiment of the present invention. The high speed dubbing apparatus **100** illustrated in FIG. **1** includes: a read section **20**; a first buffer **30**; a navigation pack generator (NV_PCK generator) **40**; a second buffer **50**; and a write section **60**. The read section **20** includes: a read unit **22**; and a stream analyzer **26**. The write section **60** includes: a stream rewriting unit **62**; and a write unit **64**. In the high speed dubbing apparatus **100**, a bit stream is read out from a first storage device **10**, the readout bit stream conforming to the DVD-VR standard (DVD Specifications for Rewritable/Re-recording Discs, Part 3) is converted into a bit stream conforming to the DVD-video standard (DVD Specifications for Read-Only Disc, Part 3) and the converted bit stream is written in a second storage device **70**.

[0037] In the following embodiments, it is assumed that the storage device **10** is a hard disk drive and the storage device **70** is a DVD-R (DVD-Recordable) drive, as an example. The storage device **10** may be a device which outputs a bit stream conforming to the DVD-VR standard, and may be a DVD-RW (DVD-Rewritable) drive or a DVD-RAM (DVD-Random Access Memory) drive, for example. The storage

device **70** may be a device in which a bit stream conforming to the DVD-video standard can be recorded, and may be a hard disk drive or a DVD-RW drive, for example. The storage device **10** and the storage device **70** may be the same device. That is, a converted bit stream conforming to the DVD-video standard may be recorded on a device from which a bit stream conforming to the DVD-VR standard before conversion is output.

[0038] Now, the DVD-VR standard and the DVD-video standard will be described. FIG. **2** is an explanatory diagram illustrating a directory structure of a disk on which information is recorded according to the DVD-VR standard. As illustrated in FIG. **2**, directories of this disk have a hierarchy. A DVD_RTAV is provided under a ROOT directory. This directory includes files: VR_MANGR.IFO, VR_MOVIE.VRO, VR_STILL.VRO, VR_AUDIO.VRO and VR_MANAGER.BUP.

[0039] The VR_MANGR.IFO is a file for video management information. Specifically, the VR_MANGR.IFO includes a start address, a time zone, a character code, basic information on a recorded disk, video/audio attributes, information on a still-picture file, playback start/end time, search information on video/audio attributes, an entry point, information on a program chain such as text information, text information on a program and a play list, and other information.

[0040] Video data, audio data and subpicture data to be played back from a DVD are stored in the VR_MOVIE.VRO. Each of the video data and the audio data is constituted by a plurality of files in units of VOBs (Video Objects). A still picture is stored in the VR_STILL.VRO. Audio data for displaying a still-picture is stored in the VR_AUDIO.VRO. The VR_MANAGER.BUP is a backup of the VR_MANGR.IFO.

[0041] FIG. **3** is an explanatory diagram illustrating a directory structure of a disk on which information is recorded according to the DVD-video standard. A disk conforming to the DVD-video standard has a single DVD Video Zone. The DVD Video Zone is constituted by a VMG (Video Manager) and a plurality of VTSs (Video Title Sets). Each

of the VTSs is constituted by a VTSI (Video Title Set Information), a VTSM_VOBS, a VTSTT_VOBS and a VTSI for backup.

[0042] The VTSI includes information on playback control of data included in one of the VTSs. In the VTSM_VOBS, information used for a menu of a DVD is stored. Video data, audio data and subpicture data are stored in the VTSTT_VOBS. Each of the video data and audio data is constituted by a plurality of files in units of VOBs.

[0043] In a digital conversion, most of the circuit resources and software resources are used to convert VOBs of moving images and audio included in the VR_MOVIE.VRO conforming to the DVD-VR standard into VOBs conforming to the DVD video format standard.

[0044] FIG. **4** is an explanatory diagram illustrating structures of VOBs conforming to the DVD-VR standard and the DVD-video standard, respectively. Each of the VOBs is constituted by a plurality of VOBUs (Video Object Units). In this aspect, the VOBs are common to both of the standards. Each of the VOBUs is constituted by a plurality of packs. Each pack is data of 2048 bytes.

[0045] In the DVD-VR standard, each pack is one of a real time data information pack (RDI_PCK), a video pack (V_PCK) and an audio pack (A_PCK). In the DVD-video standard, each pack is one of a navigation pack (NV_PCK), a video pack and an audio pack. In FIG. **4**, the hatched sections indicate packs including PES_extension_fields.

[0046] In this embodiment, the number of VOBUs in a VOB and the length of the VOB are the same between both of the DVD-VR standard and the DVD-video standard. However, none of the number and the length is specifically defined in the standards. In FIG. **4**, the RDI_PCK is placed at the head of each VOBU. However, the head pack of each VOBU is not necessarily the RDI_PCK.

[0047] FIG. **5** is an explanatory diagram illustrating a structure of a real time data information pack (RDI_PCK). The RDI_PCK is a pack for storing real time information. Real time data and user data are stored in a portion indicated by RDI data in FIG. **5**.

DCI_CCI_SS information is recorded in the 21st byte from the head of the RDI data. CCI information (Copy Control Information) is recorded in the 23rd byte. CCI_SS information is recorded in the first through third bits in the DCI_CCI_SS.

[0048] The CCI_SS information indicates whether the CCI information is valid or not. If the CCI_SS information indicates that the CCI information is valid, the CCI information becomes valid. The eighth through sixth bits in the CCI in information are called CGMS (Copy Generation Management System) information and represent copyright information for copy management of the content. If these bits indicate 0x0 (where 0x is added to indicate a hexadecimal number), copying of a content is prohibited. If these bits indicate 0x4, copying of the content is allowed. Dubbing cannot be performed on a content which is not allowed to be copied.

[0049] A Pack Header contains a pack header code, time information on the pack (SCR: System Clock Reference), for example. A System Header indicates a bit rate and buffer information, for example. A Packet Header indicates a PES Header of each pack. The type of a pack is determined by a stream ID (stream_id) in this Packet Header and a substream ID (sub_stream_id).

[0050] FIG. **6** is an explanatory diagram illustrating a structure of a navigation pack (NV_PCK). The NV_PCK is a pack in which positional information on data to be played back and copyright information, for example, are stored. A Pack Header, a System Header, a Packet Header and a sub_stream_id are the same as those in the RDI_PCK.

[0051] FIG. **7** is an explanatory diagram illustrating structures of video packs (V_PCKs). The video packs are packs in which image information is stored. Image data is stored in a portion indicated by a Video data in FIG. 7. A Pack Header, a System Header and a Packet Header are the same as those in the RDI_PCK. If a video pack is a leading pack of a VOBU, this video pack includes a System Header. Otherwise, the video pack includes no System Header.

[0052] FIG. **8** is an explanatory diagram illustrating structures of audio packs

(A_PCKs). The audio packs are packs in which audio data is stored. FIG. **8** show a case in which an audio pack contains audio data in the AC3 format and a case in which an audio pack contains audio data in the linear pulse code modulation (LPCM) format. A Pack Header, a System Header, a Packet Header and a sub_stream_id are the same as those in the RDI_PCK. Audio frame information indicates a frame number, for example, of audio data included in a pack.

[0053] In addition, in the case of the LPCM format, the audio pack includes audio data information. This information includes data indicating the number of quantization bits (quantization_word_length), a sampling frequency (audio_sampling_frequency), the number of channels (number_of_audio_channels) and range control (dynamic_range_control).

[0054] Now, differences in VOB structure between the DVD-VR standard and the DVD-video standard will be described. Aspects that are permitted in the DVD-VR standard but are not permitted in the DVD-video standard are as follows:

(a) changes in resolution and aspect ratio of pictures

(b) a change in audio attribute

(c) dual mono audio data

(d) VOBUs having playback times of 0.4 sec. or less

In addition, both of the standards have the following differences:

(e) An SCR in the leading pack of a VOB does not need to be zero in the DVD-VR standard but should be zero in the DVD-video standard.

(f) A PES_extension_field included in a pack header is added to the leading pack of each type of packs in each VOBU in the case of the DVD-VR standard, but is allowed to be added only to the leading pack of each type of packs in a VOB in the case of the DVD-video standard.

[0055] FIG. **9** is a block diagram illustrating an example of a configuration of the first storage device **10** from which a bit stream is read out. The first storage device **10**

illustrated in FIG. **9** includes: a read/write unit **14**; and a cache memory **16**. The read/write unit **14** reads data from a recording medium **12** and writes data in the recording medium **12**.

[0056] FIG. **10** is a block diagram illustrating an example of a configuration of the second storage device **70** in which a bit stream is written. The second storage device **70** illustrated in FIG. **10** includes: a read/write unit **74** and a cache memory **76**. The read/write unit **74** writes data in a recording medium **72**. The recording medium **72** is a DVD-R disk, for example, and is removable from the second storage device **70**.

[0057] The high speed dubbing apparatus illustrated in FIG. **1** will be described. A bit stream conforming to the DVD-VR standard is stored in the recording medium **12** in the first storage device **10**. The stored bit stream is a bit stream whose video resolution, aspect ratio and audio attributes do not change and which has a playback time of 0.4 seconds or more for each VOBU except for the last VOBU.

[0058] FIG. **11** is a block diagram illustrating a configuration of the read unit **22** illustrated in FIG. **1**. The read unit **22** includes: a read-command issuing unit **21**; and a read-command controlling unit **23**. The read-command controlling unit **23** issues a read instruction RDI to the read-command issuing unit **21**. The read instruction RDI contains an address of data stored in the storage device **10** to be read out and read permission.

[0059] Upon reception of the read instruction RDI, the read-command issuing unit **21** issues a read command RDC to the storage device **10**. Upon reception of the read command RDC, the storage device **10** reads a content in the DVD-VR standard format, and outputs the content to the stream analyzer **26** as a bit stream DVR. When reading is finished, the read-command issuing unit **21** outputs an end signal ENS to the read-command controlling unit **23**. The read-command controlling unit **23** does not issue the next read command RDC until the end signal ENS is received.

[0060] FIG. **12** is an explanatory diagram illustrating a storage state of a content in the DVD-VR standard format in the storage device **10** illustrated in FIG. **1**. In this case, data is managed in units of 16 bits. In FIG. **12**, the content in the DVD-VR

standard format is stored as 16-bit data DT1, DT2, ... For example, one block occupies a region corresponding to α words (where one word is 16 bits).

[0061] In this manner, the read unit **22** reads a bit stream DVR conforming to the DVD-VR standard from the storage device **10** and outputs the bit stream DVR to the stream analyzer **26**. The stream analyzer **26** analyzes the bit stream DVR and outputs the obtained stream analysis information SI to the NV_PCK generator **40** and the stream rewriting unit **62** and also outputs a bit stream to the buffer **30**. The buffer **30** stores the received bit stream and then outputs the bit stream to the NV_PCK generator **40**.

[0062] The stream analysis information SI is information necessary for converting a bit stream conforming to the DVD-VR standard into a bit stream conforming to the DVD-video standard, and includes information such as an SCR, structures of a VOB and VOBUs, an A_SYNCA, a VOBU_2NDREF_EA, a VOBU_3RDREF_EA, for example.

[0063] The NV_PCK generator **40** performs NV_PCK generation. Specifically, the NV_PCK generator **40** generates an NV_PCK from information such as the A_SYNCA, the VOBU_2NDREF_EA, the VOBU_3RDREF_EA contained in the stream analysis information SI, replaces the RDI_PCK in the bit stream output from the buffer **30** by the generated NV_PCK (see, FIG. **4**), and outputs the obtained bit stream to the buffer **50**. The buffer **50** stores the received bit stream and then outputs the bit stream to the stream rewriting unit **62**.

[0064] The stream rewriting unit **62** performs stream rewriting. Specifically, the stream rewriting unit **62** rewrites a time stamp and removes a PES_extension_field with respect to the bit stream input from the second buffer **50**, based on the stream analysis information SI, and outputs a bit stream DV conforming to the DVD-video standard to the write unit **64**.

[0065] In other words, the stream rewriting unit **62** detects a leading pack of a VOB for each type of packs based on structures of a VOB and VOBUs and SCR included in the stream analysis information SI, subtracts the time indicated by an SCR

in the leading pack of the VOB from time information such as an SCR in a Pack Header of a pack forming a bit stream, a PTS (Presentation Time Stamp) and a DTS (Decoding Time Stamp) in a Packet Header, and replaces the original SCR, PTS and DTS by the subtraction results. The stream rewriting unit **62** removes a PES_extension_field in each pack except for the leading pack of the VOB with respect to each type of packs, and outputs the obtained bit stream to the write unit **64**.

[0066] FIG. **13** is an explanatory diagram illustrating removal of a PES_extension_field using stuffing bytes. In a packet including a PES_extension_field (indicated by Ex in FIG. **13**), if no padding packet is provided and stuffing bytes are less than five bytes, the bits of the PES_extension_field_flag are rewritten to zero and then the portion corresponding to the PES_extension_field is overwritten with stuffing bytes.

[0067] FIG. **14** is an explanatory diagram illustrating removal of a PES_extension_field using a padding packet. In a packet including a PES_extension_field, if conditions that no padding packet is provided and stuffing bytes are less then 5 bytes are not satisfied, the bits of the PES_extension_field_flag are rewritten to zero and the PES_extension_field and the stuffing bytes are removed from the packet, and the removed data is compensated by a padding packet having the same length as the removed data.

[0068] The write unit **64** writes a bit stream output from the stream rewriting unit **62** in the recording medium **72** in the second storage device **70**, as a bit stream DV.

[0069] FIG. **15** is a timing chart showing an example of processing in the high speed dubbing apparatus **100** illustrated in FIG. **1**. In FIG. **15**, processes performed on a block 1, a block 2 and a block 3 and the time necessary for each of the processes are shown. The blocks 1 through 3 are continuous portions of a bit stream recorded on the recording medium **12** in the storage device **10**, and each of the amounts of the blocks 1 through 3 is equal to the capacity of the buffer **30**. In the high speed dubbing apparatus **100**, a process such as reading is performed on each block.

[0070] Processing in the high speed dubbing apparatus **100** can be divided into

processes P1, P2 and P3. The process P1 is a process starting from readout of a bit stream from the storage device **10** to storage of the bit stream in the buffer **30**, and includes a stream reading process by the read unit **22** and a stream analysis process by the stream analyzer **26**. The process P2 is a process starting from readout of a bit stream from the buffer **30** to storage of the bit stream in the buffer **50**, and includes an NV_PCK generation process by the NV_PCK generator **40**. The process P3 is a process starting from readout of a bit stream from the buffer **50** to storage of the bit stream in the storage device **70**, and includes a stream rewriting process by the stream rewriting unit **62** and a stream writing process by the write unit **64**.

[0071] The high speed dubbing apparatus **100** operates to perform the processes P1 through P3 in parallel, as shown in FIG. **15**. The parallel processes P1 through P3 start at the same time. Accordingly, until one of the processes P1 through P3 requiring the longest time terminates, wait states exist after the other processes. In the case of FIG. **15**, the time necessary for the process P1 (i.e., the stream reading process and the stream analysis process) is the longest among the processes P1 through P3, and this time corresponds to the time necessary for dubbing of a unit block. In this manner, pipeline operation is performed on the processes P1 through P3. In a case where no pipeline operation is performed, the total time necessary for the processes P1 through P3 is approximately equal to the time necessary for dubbing of a unit block. Accordingly, the high speed dubbing apparatus **100** illustrated in FIG. **1** enables high-speed dubbing.

[0072] An ATA (AT Attachment) or an ATAPI (AT Attachment Packet Interface), for example, connects the read unit **22** and the storage device **10** together or the write unit **64** and the storage device **70** together. The read unit **22** and the write unit **64** transfer data to/from the storage devices **10** and **70**, respectively, as fast as possible using a command such as an UDMA (Ultra Direct Memory Access) in this interface.

[0073] FIG. **16** is a timing chart showing an example of data transfer between the read unit **22** and the storage device **10** illustrated in FIG. **1**. In the case of data transfer using a command such as an UDMA, the time for a command issue sequence is

needed before the transfer starts and the time for a command termination sequence is needed after the transfer is finished.

[0074] One VOBU includes one NV_PCK at the maximum. Accordingly, if the size of the buffers **30** and **50** is less than one VOBU, NV_PCK generation is not performed in some cases, so that processing efficiency can decrease because of overhead. In view of this, the size of the buffers **30** and **50** is set enough to store at least a bit stream of one VOBU. This ensures NV_PCK generation.

[0075] As the capacity of the buffer **30** increases, overhead associated with an ATA command or an ATAPI command as shown in FIG. **16** decreases, and the efficiency of transfer is enhanced. However, if the capacity of the buffer is larger than that of the cache memory **16** in the storage device **10**, the amount of data transferred at a time exceeds the capacity of the cache memory **16** and readout from the recording medium **12** must be performed for every capacity of the cache memory **16**. In this case, data transfer is repeated at every time T as shown in FIG. **16**.

[0076] If data transfer is divided and performed, a period during which reading from the recording medium **12** is performed is a wait time during which no data transfer is performed, so that transfer speed does not increase. In view of this, the capacity of the buffer **30** is set at a value equal to or less than the capacity of the cache memory **16**. Then, data transfer between the cache memory **16** and the read unit **22** is not divided and the wait time is reduced. In particular, the capacity of the buffer **30** is preferably equal to that of the cache memory **16**. This is because it is possible to reduce overhead associated with the ATA command or the ATAPI command, while reducing the wait time.

[0077] Likewise, with respect to data transfer between the write unit **64** and the storage device **70**, data transfer is divided and performed for every capacity of the cache memory **76**. Accordingly, the capacity of the buffer **50** is equal to or less than the capacity of the cache memory **76** and is preferably equal to the capacity of the cache memory **76**.

[0078] FIGS. **17(a)**, **(b)** and **(c)** are timing charts showing examples of the case of

performing two processes in parallel in the high speed dubbing apparatus **100** illustrated in FIG. **1**. The case of performing three processes in parallel in the high speed dubbing apparatus **100** has been described with reference to FIG. **15**. Alternatively, two processes may be performed in parallel, as shown in FIGS. **17(a)** through **(c)**. It is herein assumed that the periods necessary for the respective processes P1 through P3 are the same for simplicity.

[0079] FIG. **17(a)** shows a case where the process P3 is performed in parallel while the process P1 or P2 shown in FIG. **15** is performed. FIG. **17(b)** shows a case where the process P2 is performed in parallel while the process P3 or P1 shown in FIG. **15** is performed. FIG. **17(c)** shows a case where the process P1 is performed in parallel while the process P2 or P3 shown in FIG. **15** is performed.

[0080] The stream analysis information SI may be accumulated in the recording medium **12** together with a bit stream. In such a case, the stream analysis information SI is read out from the recording medium **12** and is used.

[0081] In this manner, in the high speed dubbing apparatus **100** illustrated in FIG. **1**, the buffers **30** and **50** allow a read process from the storage device **10** or a write process in the storage device **70** to be performed in parallel with another process. Accordingly, a dubbing process in which a bit stream conforming to the DVD-VR standard format is read out and is converted into a bit stream conforming to the DVD-video standard format to be written is performed at high speed.

[0082] (EMBODIMENT 2)

FIG. **18** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a second embodiment of the present invention. The high speed dubbing apparatus **200** illustrated in FIG. **18** includes a buffer checking unit **80**, in addition to the components of the high speed dubbing apparatus **100** illustrated in FIG. **1**. The first and second buffers **30** and **50** are replaced with first and second buffers **230** and **250**. The other components are the same as described with reference to FIG. **1**, and description thereof will be omitted.

[0083] The buffer checking unit **80** reads a sufficient amount of data from a

storage device **10** while a read unit **22** does not operate. At this time, data in an amount corresponding to the capacity of a cache memory **16** in the storage device **10** is transferred at each time. If the size of a data block (data transfer (N) in FIG. **16**) to be transferred first is equal to the size of a data block (e.g., data transfer (M) in FIG. **16**) to be transferred next or later, this size is considered the capacity of the cache memory **16**. Accordingly, the buffer checking unit **80** defines this size as the buffer size of a buffer **230**, and outputs a signal indicating the buffer size to the buffer **230**. The buffer **230** adjusts the capacity thereof to the size specified by the signal indicating the buffer size.

[0084] If the size of a data block (data transfer (N) in FIG. **16**) to be transferred first differs from the size of a data block (e.g., data transfer (M) in FIG. **16**) to be transferred next or later, the buffer checking unit **80** defines the most frequent size as the buffer size of the buffer **230**.

[0085] In the same manner, the buffer checking unit **80** writes a sufficient amount of data in an unused region of a storage device **70** while a write unit **64** does not operate. At this time, data in an amount corresponding to the capacity of a cache memory **76** in the storage device **70** is transferred at each time. If the size of a data block to be transferred first is equal to the size of a data block to be transferred next or later, the buffer checking unit **80** defines this size as the buffer size of a buffer **250**, and outputs a signal indicating the buffer size to the buffer **250**. The buffer **250** adjusts the capacity thereof to the size specified by the signal indicating the buffer size.

[0086] If the size of a data block to be transferred first differs from the size of a data block to be transferred next or later, the buffer checking unit **80** defines the most frequent size as the buffer size of the buffer **250**.

[0087] If the defined buffer size differs between the buffers **230** and **250**, the buffer checking unit **80** defines the smaller buffer size as the buffer size of the buffers **230** and **250**.

[0088] In this manner, in the high speed dubbing apparatus illustrated in FIG. **18**, the size of a buffer is optimized according to the configuration of a storage device in

which a bit stream is stored, thus ensuring reduction of the time necessary for dubbing. In addition, in the case of changing a storage device, e.g., the case of replacing a hard disk drive, the size of a buffer is also allowed to be optimized.

[0089] If the time necessary for transferring one data block is the time T as shown in FIG. **15**, the interval between stream reading in FIG. **16** or between stream writing is not shorter than the time T. Accordingly, pipeline operation needs to be kept waiting so as to prevent the length corresponding to one stage of pipeline from being smaller than the time T.

[0090] (EMBODIMENT 3)

FIG. **19** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a third embodiment of the present invention. The high speed dubbing apparatus **300** illustrated in FIG. **19** includes a storage device **310** and a read section **320** instead of the storage device **10** and the read section **20**, respectively, in the high speed dubbing apparatus **100** illustrated in FIG. **1** and does not include the navigation pack generator **40** and the second buffer **50**. The storage device **310** has a configuration similar to that of the storage device **10**. The read section **320** includes: a read unit **322**; a filter **324**; and a stream analyzer **326**. The other components are the same as described with reference to FIG. **1**, and description thereof will be omitted.

[0091] FIG. **20** is an explanatory diagram illustrating an example of a format of a bit stream output from the storage device **310** illustrated in FIG. **19**. The storage device **310** reads a bit stream from a recording medium and outputs the bit stream to the read unit **322** as a bit stream DVN. The bit stream DVN is a bit stream in which an NV_PCK (i.e., "N" in FIG. **20**) is added before an RDI_PCK (i.e., "R" in FIG. **20**) in a bit stream conforming to the general DVD-VR standard.

[0092] The recording medium from which data is read out by the storage device **310** stores a bit stream including both an RDI_PCK and a previously-generated NV_PCK. The RDI_PCK or the NV_PCK may be stored in a region different from regions in which other packs of the bit stream are stored. For the RDI_PCK and the

NV_PCK, the same value is used as common variables (e.g., SCR).

[0093] In the case of usual playback, for example, i.e., if a bit stream conforming to the DVD-VR standard is needed, the filter **324** removes an NV_PCK from a bit stream output from the read unit **322** and outputs the resultant bit stream to the stream analyzer **326**. In the case of high-speed dubbing, i.e., if a bit stream conforming to the DVD-video standard is written in a recording medium, the RDI_PCK is removed from the bit stream output from the read unit **322** and the resultant bit stream is output to the stream analyzer **326**.

[0094] The stream analyzer **326** is the same as the stream analyzer **26** in FIG. **1** except for that data for NV_PCK generation is unnecessary.

[0095] In the high speed dubbing apparatus illustrated in FIG. **19**, an NV_PCK does not need to be generated during dubbing. Accordingly, the process P2 in FIG. **15** is unnecessary and the processes P1 and P3 in FIG. **15** are performed in parallel. As a result, the dubbing speed is not limited by the process P2.

[0096] In this manner, a bit stream to which an NV_PCK is previously added is stored in the storage device **310**, generation of an NV_PCK is unnecessary and the second buffer **50** illustrated in FIG. **1** is not needed. Though the amount of the bit stream to be stored in the storage device **310** is increased because of the addition of the NV_PCK, no significant influence occurs because only one NV_PCK is added for each one VOBU (0.4 seconds or more).

[0097] In the foregoing embodiments, the time necessary for a dubbing process in which a bit stream conforming to the DVD-VR standard format is read out and a bit stream conforming to the DVD-video standard format is written is reduced.

[0098] (EMBODIMENT 4)

FIG. **21** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a fourth embodiment of the present invention. The high speed dubbing apparatus **400** illustrated in FIG. **21** includes first storage devices **410** and **412** and a read section **420** instead of the storage device **10** and the read section **20** of the high speed dubbing apparatus **100** illustrated in FIG. **1**. The

storage devices **410** and **412** are similar to the storage device **10** except for that continuous data constituting a content is divided and stored in two storage devices. The read section **420** includes: a read unit **422**; and a stream analyzer **26**. The other components are the same as described with reference to FIG. **1**, and description thereof will be omitted.

[0099] FIG. **22** is a block diagram illustrating a configuration of the read unit **422** illustrated in FIG. **21**. The read unit **422** includes: a read-command issuing unit **421**; a read-command controlling unit **423**; buffers **402** and **404**; and a selector **406**.

[0100] As the read-command controlling unit **23** illustrated in FIG. **11**, a read-command controlling unit **423** issues a read instruction RDI to the read-command issuing unit **421**. Upon reception of the read instruction RDI, the read-command issuing unit **421** issues read commands RDC1 and RDC2 to the respective storage devices **410** and **412** at the same time.

[0101] Upon reception of the read command RDC1, the storage device **410** reads a content in the DVD-VR standard format, and outputs the content to the buffer **402** as a bit stream DVR1. Upon reception of the read command RDC2, the storage device **412** reads a content in the DVD-VR standard format, and outputs the content to the buffer **404** as a bit stream DVR2. That is, the storage devices **410** and **412** perform reading in parallel.

[0102] The buffers **402** and **404** output the received data to the selector **406**. The selector **406** alternately selects data from the buffers **402** and **404**, and outputs the selected data to the stream analyzer **26** as a bit stream conforming to the DVD-VR standard. Even if the read commands RDC1 and RDC2 are issued at a time, the storage devices **410** and **412** do not always finish reading at a time. Accordingly, the buffers **402** and **404** have a buffer capacity enough to absorb the difference in processing termination time. The read-command issuing unit **421** outputs an end signal ENS to the read-command controlling unit **423** when both data transmission to the buffer **402** and data transmission to the buffer **404** are terminated.

[0103] FIG. **23** is an explanatory diagram illustrating storage states of a content in

the DVD-VR standard format in the two storage devices **410** and **412** illustrated in FIG. **22**. In this embodiment, data is managed in units of 32 bits. The storage device **410** stores the higher-order 16 bits in each 32-bit data, whereas the storage device **412** stores the lower-order 16 bits in each 32-bit data.

[0104] Specifically, the higher-order 16-bit data DT1A and the lower-order 16-bit data DT1B constituting 32-bit data are stored in the respective storage devices **410** and **412**, and the higher-order 16-bit data DT2A and the lower-order 16-bit data DT2B constituting next 32-bit data are stored in the respective storage devices **410** and **412**. In other words, the successive 16-bit data DT1A, DT1B, DT2A, DT2B, ... are alternately stored in the storage devices **410** and **412**.

[0105] For example, suppose the capacity of one block is α words, a region corresponding to $\alpha/2$ words is occupied for this block in each of the storage devices **410** and **412**. In view of this, the read-command issuing unit **421** reduces an address specified by the received read instruction RDI by half and specifies the address in the read commands RDC1 and RDC2.

[0106] In the foregoing example, data conforming to the DVD-VR standard is divided into units of 16 bits and stored. Alternatively, the data may be divided into units of, for example, 8 bits or other number of bits to be stored.

[0107] FIG. **24** is a timing chart showing an example of processing in the high speed dubbing apparatus **400** illustrated in FIG. **21**. For comparison, a timing chart for the high speed dubbing apparatus **100** illustrated in FIG. **1** is also shown in an upper portion of FIG. **24**. In the high speed dubbing apparatus **400**, data is simultaneously read out from the storage devices **410** and **412** in parallel, so that the time necessary for reading a stream is reduced by approximately half. As a result, a dubbing process is performed at higher speed than in the high speed dubbing apparatus **100** illustrated in FIG. **1**.

[0108] (EMBODIMENT 5)

FIG. **25** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a fifth embodiment of the present invention.

The high speed dubbing apparatus **500** illustrated in FIG. **25** includes first storage devices **510** and **512**, a read section **520** and buffers **530** and **532**, instead of the first storage device **10**, the read section **20** and the first buffer **30** of the high speed dubbing apparatus **100** illustrated in FIG. **1** and further includes selectors **534** and **536**. The storage devices **510** and **512** are similar to the storage device **10** except for that continuous data constituting a content is divided and stored in two storage devices. The read section **520** includes: a read unit **522**; and stream analyzers **526** and **527**. The other components are the same as described with reference to FIG. **1**, and description thereof will be omitted.

[0109] FIG. **26** is an explanatory diagram illustrating storage states of a content in the DVD-VR standard format in the two storage devices **510** and **512** illustrated in FIG. **25**. The storage device **510** stores data in odd-numbered blocks and the storage device **512** stores data in even-numbered blocks. That is, successive blocks are alternately stored in the storage devices **510** and **512**. Accordingly, as compared to a case where only one storage device stores data, half of the region of each of the storage devices **510** and **512** is occupied. The respective blocks are subjected to alignment in processing units (VOBUs) for high-speed dubbing. That is, the size of each block is an integral multiple of a VOBU.

[0110] FIG. **27** is a block diagram illustrating a configuration of the read unit **522** illustrated in FIG. **25**. The read unit **522** includes: a read-command issuing unit **521**; and a read-command controlling unit **523**.

[0111] The read-command controlling unit **523** issues a read instruction RDI to the read-command issuing unit **521**. Upon reception of the read instruction RDI, if a specified address is an address indicating an odd-numbered block, the read-command issuing unit **521** issues a read command RDC1 to the storage device **510**, whereas if the specified address is an address indicating an even-numbered block, the read-command issuing unit **521** issues a read command RDC2 to the storage device **512**.

[0112] Upon reception of the read command RDC1, the storage device **510** reads a content in the DVD-VR standard format and outputs the content to the stream analyzer

526 as a bit stream DVR1. Upon reception of the read command RDC2, the storage device **512** reads a content in the DVD-VR standard format and outputs the content to the stream analyzer **527** as a bit stream DVR2. The read-command issuing unit **521** outputs an end signal ENS to the read-command controlling unit **523** at every termination of an issue of the read command RDC1 or RDC2.

[0113] The stream analyzers **526** and **527** analyze the respective bit streams DVR1 and DVR2, and output the obtained stream analysis information to the selector **536**. The stream analyzers **526** and **527** output the bit streams to the respective buffers **530** and **532**.

[0114] The selector **536** selects the stream analysis information output from one of the stream analyzers **526** and **527**, and outputs the selected information to an NV_PCK generator **40** and a stream rewriting unit **62**. The buffers **530** and **532** output the input bit streams to the selector **534**. The selector **534** selects a bit stream from one of the stream analyzers **526** and **527** selected by the selector **536**, and outputs the bit stream to the NV_PCK generator **40**.

[0115] FIG. **28** is a timing chart showing an example of processing in the high speed dubbing apparatus **500** illustrated in FIG. **25**. As shown in FIG. **28**, in the high speed dubbing apparatus **100** illustrated in FIG. **1**, until stream analysis for one block is terminated, a stream in the next block cannot be read out. In addition, if the time necessary for stream readout and stream analysis is longer than either one of the time necessary for stream rewriting and stream storage and the time necessary for NV_PCK generation, a wait time is generated.

[0116] In the high speed dubbing apparatus **500** illustrated in FIG. **25**, stream readout and stream analysis is allowed to be performed before stream readout and stream analysis for the previous block is terminated, as illustrated in FIG. **28**. Accordingly, the wait time is reduced.

[0117] (EMBODIMENT 6)

FIG. **29** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a sixth embodiment of the present invention.

The high speed dubbing apparatus **600** illustrated in FIG. **29** includes an NV_PCK generator **640** and a write section **660** instead of the NV_PCK generator **40** and the write section **60**, respectively, of the high speed dubbing apparatus **100** illustrated in FIG. **1** and further includes a write unit **668**. The write section **660** includes a stream rewriting unit **662** and a write unit **64**. The other components are the same as described with reference to FIG. **1**, and description thereof will be omitted.

[0118] The stream rewriting unit **662** is different from the stream rewriting unit **62** illustrated in FIG. **1** in that upon reception of a stream in the DVD-video standard format, the stream rewriting unit **662** adds a PES_extension_field to the first-input NV_PCK and performs replacement of SCRs. The NV_PCK generator **640** is different from the NV_PCK generator **40** illustrated in FIG. **1** in that an NV_PCK is corrected and output when a stream in the DVD-video standard format is input.

[0119] In high-speed dubbing of a stream in the DVD-VR standard format, the NV_PCK generator **640** generates an NV_PCK and outputs a stream to the stream rewriting unit **662** through a second buffer **50**, in the same manner as the NV_PCK generator **40** illustrated in FIG. **1**.

[0120] At this time, the stream rewriting unit **662** rewrites an SCR, a PTS and a DTS in the same manner as the stream rewriting unit **62** illustrated in FIG. **1**, thereby converting the input stream into a stream in the DVD-video standard format and outputting the resultant stream. The stream in the DVD-video standard format output from the stream rewriting unit **662** is output not only to the write unit **64** but also to the write unit **668**. The write unit **668** writes the input stream in the DVD-video standard format in a storage device **10**. At this time, the input stream is written in a region different from a region where a stream in the DVD-VR standard format before conversion is stored in the storage device **10**.

[0121] After termination of high-speed dubbing of a stream in the DVD-VR standard format, to perform high-speed dubbing of the entire portion of the same content again, a converted stream recorded in the storage device **10** is read out by a read unit **22** and then the write unit writes the stream in a storage device **70** without

change. That is, in this case, the NV_PCK generator **640** and the stream rewriting unit **662** do not rewrite the stream.

[0122] To perform high-speed dubbing of a portion of the same content again after termination of high-speed dubbing of a stream in the DVD-VR standard format, the NV_PCK generator **640** and the stream rewriting unit **662** perform the following processing. That is, the NV_PCK generator **640** modifies time information such as an SCR, a PTS and a DTS, for example, included in an NV_PCK in a converted stream read out by the read unit **22**, and sends the modified stream to the stream rewriting unit **662** through the buffer **50**. The stream rewriting unit **662** removes PES_extension_fields when necessary in such a manner that a PES_extension_field is present only in the leading pack of each of a video content, an audio content and a subpicture content. The stream rewriting unit **662** also modifies the SCR, the PTS and the DTS again.

[0123] In this manner, in the high speed dubbing apparatus **600** illustrated in FIG. **29**, the stream subjected to format conversion is stored in the storage device **10** and is used as a cached stream. Accordingly, the time necessary for processing on an NV_PCK and stream rewriting is reduced, so that the dubbing speed in a case where dubbing is performed multiple times is increased.

[0124] (EMBODIMENT 7)

FIG. **30** is a block diagram illustrating an example of a configuration of a high speed dubbing apparatus according to a seventh embodiment of the present invention. The high speed dubbing apparatus **700** illustrated in FIG. **30** includes a read section **720** and a write section **760**, instead of the read section **20** and the write section **60**, respectively, of the high speed dubbing apparatus **100** illustrated in FIG. **1**. The read section **720** includes: a read unit **22**; and a stream analyzer **726**. The write section **760** includes: a stream rewriting unit **62**; a filter **766**; and a write unit **64**. The other components are the same as described with reference to FIG. **1**, and description thereof will be omitted.

[0125] The stream analyzer **726** is different from the stream analyzer **26** illustrated

in FIG. **1** in having the function of monitoring a CGMS shown in FIG. **5**. The stream analyzer **726** performs stream analysis on an input stream in the DVD-VR standard format, outputs stream analysis information SI as the stream analyzer **26**, analyzes a CGMS and outputs the obtained CGMS analysis information CI to the filter **766**.

[0126] If the CGMS analysis information CI indicates allowance of copying, the filter **766** produces an output from the stream rewriting unit **62** without change. If the CGMS analysis information CI indicates prohibition of copying, the output from the stream rewriting unit is not output. When a stream indicating allowance of copying is input to the filter **766** after detection of a stream indicating prohibition of copying, the subsequent stream indicating allowance of copying is subjected to modification again for a SCR, a PTS and a DTS.

[0127] FIG. **31** is an explanatory diagram illustrating remodification of SCRs. FIG. **31** shows a stream on which high-speed dubbing is to be performed. Copying of the first portion of this stream is allowed, copying of the second portion thereof is prohibited, and copying of the third portion thereof is allowed. When high-speed dubbing starts, the leading SCR is Ta, each of the SCRs in the subsequent packs is calculated by:

(output SCR) = (SCR of input packet) − Ta

[0128] Then, when a subsequent stream which is not allowed to be copied is input, this stream is not output to outside. Thereafter, when a subsequent stream which is allowed to be copied is input, time information becomes discontinuous because no SCR associated with a stream which is not allowed to be copied is contained in a stream to be output to outside. When the time information becomes discontinuous, a stream fails to be played back in some cases.

[0129] To prevent this, when a stream which is not allowed to be copied is input, the filter **766** holds an SCR (Tb) in the leading pack and, when a stream which is allowed to be copied (and in which an SCR in its leading pack is Tc) is input again, the filter **766** modifies the SCR according to the equation:

(output SCR) = (SCR in input packet) − Ta − (Tc − Tb)

and outputs the resultant SCR. Then, no discontinuity of time information between streams of a content which is allowed to be copied occurs. The filter **766** also performs similar processing on PTSs and DTSs.

[0130] In this manner, in the high speed dubbing apparatus **700** illustrated in FIG. **30**, even in a case where contents which are allowed to be copied and contents which are not allowed to be copied both exist, high-speed dubbing of a content which is allowed to be copied is enabled.

INDUSTRIAL APPLICABILITY

[0131] As described above, in a high speed dubbing apparatus according to the present invention, reading of a bit stream in the DVD-VR standard, conversion of the bit stream into a bit stream in the DVD-video standard to write the resultant bit stream are performed at high speed. Accordingly, the high speed dubbing apparatus is useful for, for example, DVD recorders for dubbing pictures recorded on a recording medium to another recording medium or other medium.